

The

A newsletter for the customers of
Campbell Scientific, Inc.



CAMPBELLUPDATE

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www.campbellsci.com

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The CR510: Our newest datalogger

*Get research-grade performance
in a convenient, small package*

Meet the CR510, Campbell Scientific's newest datalogger. The CR510 retains the hardware configuration of the CR500:

- Four single-ended analog input channels
- Two pulse counters
- Two switched excitation channels
- One digital control port



The CR510's design allows seamless integration into existing Campbell datalogger networks. Telecommunication options include: cellular, standard, and voice-synthesized phone modems; satellite transmitters; radios; short-haul modems; and multidrop modems. Modbus, ALERT and Table Data operating systems are available for the CR510.

Programming the CR510 is supported by Short Cut version 1.2 and PC208W software version 3.0 or greater.

The CR510 is intended for applications where fewer input channels are required:

- Stage recording
- Precipitation monitoring
- Water level in irrigation systems
- Groundwater monitoring
- Air temperature and relative humidity monitoring
- Minimum data sets for disease forecasting models

and adds some popular features of the CR10X:

- Standard non-volatile data storage 128 K (62,000 data points)
- 1 M and 2 M optional (500,000 and 1 million data points)
- Final Storage Areas 1 and 2
- Battery-backed clock
- P69 Wind Vector Instruction
- P98 Send Character Instruction



You'll still need a CR10X or CR23X for thermocouple measurements, or for using multiplexers or SDM peripherals.

For more information contact one of our applications engineers or see our product literature, Web site, or price lists.

The CR510 is a direct replacement for the CR500. It is shown above with the CR10KD, a keyboard display that can be carried from site to site to view real-time and historical data or alter programs.

Redesigned site easy to navigate

For those of you who haven't visited our home page recently, you may want to take a look at our redesigned Campbell Scientific Web site. Our new site, released December 1, is easier to navigate, includes product literature and manuals as PDF files, provides product comparisons, and displays updated data from our local weather stations using our RTDM software.

Technical and sales support are available via the site. You can also find additional information about the products in this newsletter when you see the symbol following the article.

For additional information...

This symbol at the end of an article indicates that additional information is available. Please make your selections on the enclosed customer response form.

Prices on our 1999 US and International Price Lists are now in effect. While datalogger prices remain unchanged for another year, prices on many other products have changed, including some decreases.

Message from the President

Campbell Scientific celebrates 25 years

By Paul Campbell

Twenty five years ago, Eric and Evan Campbell built the first Campbell Scientific product - a space averaging anemometer. It was a fascinating sensor. A laser was used as the light source for the anemometer located several hundred meters away. Air mass movement across the light path



was measured by correlating the scintillation pattern in the light to the average wind speed across the light path.

I remember joining the company in 1975, just prior to an anemometer being prepared for delivery. The customer who ordered the anemometer had arranged to visit our office in Logan to observe the instrument in operation. We set it up along the shoulder of a highway on a sunny August day. At first our customer was skeptical. We turned the sensor upside-down and showed that the output was of the same magnitude but of opposite polarity. We showed that the output went to zero when the light path was blocked. We then visually observed the mirage effect along the highway in which we could "see" the wind blowing across the highway, and we were able to draw a

correlation between this visual effect and the output of the instrument. At last he was convinced.

There were many who contributed to the successes of the company over the last 25 years, but I must surely acknowledge the singular contributions of Eric Campbell who led the company from 1974 until just prior to his death in 1992. During 1975, in search of a larger market, Eric and Evan began designing more general purpose field data acquisition instruments. With the advent of the microprocessor in the 1970s, Campbell Scientific was one of the first companies to offer low-power, high-precision, field dataloggers. In addition to guiding the philosophy of the company, one of Eric's great contributions was the unique combination of digital, analog, and operating system design attributes which were the foundation for many of the company's products during the first 20 years.

Another aspect of Campbell Scientific's progress has been integrating our field dataloggers into sophisticated measurement systems. Bert Tanner joined the company in 1978 and has served as our Vice President of Marketing and Customer Service since 1980. Bert's philosophical contribution has influenced the manner in which the company is represented to you, the customer. In addition, he has made significant technical contributions to integrated measurement systems ranging from automatic weather stations to boundary layer gas exchange and turbulent transport measurements.

Over the last 25 years there have been interesting changes in the technology used in field data acquisition systems. We started out using discrete logic with fairly simple, low power integrated circuits to accomplish timing for scan intervals, average multiple readings over an output

interval, etc. With microprocessors, these functions are now designed mostly in the operating system firmware, causing a fundamental change in our products toward the increased use of digital processing and more sophisticated operating systems.

Changes in technology have enabled us to design and deliver increasingly sophisticated instruments in smaller packages. When we started, all parts were soldered by hand into circuit boards that had traces only on one side of the circuit board. Then we began using circuit boards with traces on both sides and plating in the holes. Now circuit boards have multiple layers with surface mount components. Components may even be mounted on both sides of a circuit board. Some components we use are very sophisticated with links "burned" (programmable arrays) to determine logic function.

Some things have changed in the nature of your work during the last 25 years as well. Because it is easier to do so, you probably make more field measurements. You may have an automated means of data collection with the convenience of telemetry. You probably have a computer on your desk or in your lab where you carry out analysis and report results.

Campbell Scientific would not be celebrating a 25th Anniversary without you, our customers. I hope that the success of your work is enhanced by Campbell Scientific's products and services. May the next 25 years continue to be mutually rewarding.

Year 2000 concerns? We've got you covered

Standard CSI dataloggers manufactured since 1985 will output the correct year as a four-digit number in the data file. However, depending upon the datalogger model and the version of software being used, some adjustments may need to be made to hardware or software clock settings. These are easily made. When the year changes from 1999 to 2000, correct your PC's date then download it to the datalogger. Alternatively, correct *5 directly using the keyboard display.

New pyranometer now available

We've added the Kipp and Zonen model CM3 pyranometer to our US Price List (enclosed). The CM3 is a Class 2 pyranometer that provides a flat spectral response over a 305 to 2800 nm range. It is suitable for use under plant canopies or lamps, in overcast conditions, and for reflected radiation measurements. The CM3 requires a CM3MT Leveling Fixture.

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The CAMPBELLUPDATE

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CSI product applications



Framed by a church built c. 1886, Nevado Sajama (21,464 ft above sea level) rises behind the village of Sajama in western Bolivia. Ice cores taken from the summit detail global-scale changes in climate and environments.



The Nevado Sajama weather station measures a variety of meteorological and snow parameters, many redundantly.

Tropical ice cores reveal global climate histories

High-altitude weather stations in the Andes

By Dr. Douglas Hardy, Geosciences Dept., University of Massachusetts

Ice cores recently recovered from high-elevation sites within the Tropics are providing long, detailed records of past climate. These histories contain information about global-scale changes in climate as well as environmental changes in areas where most human activities occur.

Climatic information is reconstructed from ice cores by analysis of geochemical measurements made sequentially down-core, including oxygen isotopic ratios, chemistry, and the concentration of dust. Two ice cores were drilled to bedrock (each 435 ft) in July 1997 at the summit of an ice cap in the Andes of Bolivia, by Dr. Lonnie Thompson, Ohio State University, and his team. Climatologists from the

University of Massachusetts (UMass) are collaborating with these scientists to document the ice cap climate, and to better understand the atmospheric sources of geochemical variability in snow accumulating at the site.

In support of the ice core calibration, weather stations are operating

See ANDES on Page 4



Andes

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near the drill site on Sajama (21,464 ft; 18°06'S and 68°53'W), the highest peak in Bolivia, and on Nevado Illimani (20,555 ft; 16°39'S and 67°47'W), which is 200 km essentially upwind of Sajama. Both stations measure snow accumulation and ablation hourly, along with snow temperature and a variety of meteorological variables. Analysis of these data is closely tied to the results of annual snowpack studies carried out in the vicinity of the stations, and with data from NCEP global analyses (National Centers for Environmental Protection of NOAA).

The design of these stations required balancing competing goals. For example, global solar irradiance can exceed 1100 W m⁻² at mid-day, requiring mechanical aspiration of the temperature and humidity sensors. While abundant radiation could easily provide continuous power to the fans, we limited the system design to two 10 W solar panels to reduce wind loading. Consequently, the fans are operated for only one minute out of every ten. Both stations are designed around CR10X dataloggers. Data are stored on-site in the dataloggers and on SM716 storage modules, and both sites use GOES telemetry to deliver data in near-real time to UMass. The Sajama station maximizes CR10X capacity, with duplicates of most sensors and an AM416 multiplexer for thermistors and thermocouples.

Installing and servicing the stations



High camp, or 'Nido de Condors' on Nevado Illimani sits at approximately 5,500 meters (18,045 ft). The Illimani summit looms in the background.

has been an adventure — it is no mystery to us why so few weather stations operate at high altitudes.

Upon arrival at the summit, one is not inclined to dig down six feet through wind-packed snow in search of the enclosures. Several nights were spent at the summit on each visit, often in winds so strong that flapping tents precluded conversation. Prior to departure, a call to UMass by satellite phone provided a reassuring check on satellite telemetry.

The performance of the stations has been quite remarkable. After 26 months, the Sajama record for most variables is 100 percent complete to

date — this in spite of unusually heavy snow accumulation (13 ft) during the 1996-97 wet season. Data from the stations now encompass one of the most significant El Niño events of the century, and is providing valuable insight into the record of tropical ice cores.

Details on the stations and first-year results are available in the September 1998 issue of the *American Meteorological Society Bulletin*, and from our Web site at <http://www.geo.umass.edu/climate/bolivia.html>.

We would like to acknowledge the financial support of NOAA, logistical help from Carlos Escobar, and the devotion of Campbell engineers!

Do you know about the latest in Campbell Scientific software?

PC208W 3.0 Released

Version 3.0 of our general purpose datalogger support software began shipping in early December. See the July issue of the CSI Update or check our WWW site for details on new features. We recommend upgrades for users who: collect data using schedules at midnight on Windows NT systems (fixed a bug related to NT), use phone modems intensively (added hardware flow control, etc.), want quick graphing of collected data (to check sensors in the field), or need data collection using command lines and desktop shortcuts. Upgrades are \$145 per license for any earlier Windows or DOS version of PC208W or PC208. ☑ ☐

PC200W

This easy-to-use, no-cost software is

available from www.campbellsci.com/pub/outgoing/files/pc200w10.exe.

Version 1.1, scheduled for release in early spring, will support the CR510 datalogger and include the new Viewer with graphing capability. PC200W requires a direct communication link to the datalogger and is an excellent choice for beginning users or those who only need basic functionality using standard CSI sensors. (Choose PC208W if you need scheduled data collection, telecommunications, or full-featured datalogger program editing and data processing.)

RTDM

RTDM is our graphical display software that lets you build forms to display data on strip charts, dials, and digital

labels. It takes a few hours to learn the "object-oriented" style, but an excellent tutorial is available from the Help/Getting Started menu selection. RTDM will update its graphs automatically as new data is collected by PC208W and can even generate JPEG files for use on WWW sites. A new version is expected in late winter to fix some minor bugs and add a few new tools, such as a Wind Meter. This update is free until May 31, 1999 (contact support@campbellsci.com to request your upgrade and be prepared to send in your original diskettes).

A demo version is available at [ftp://www.campbellsci.com/pub/outgoing/files/rtdmeval.exe](http://www.campbellsci.com/pub/outgoing/files/rtdmeval.exe). You can also see RTDM at work at <http://weather.campbellsci.com>. ☑ ☐

Interest in SCADA systems clearly on the rise

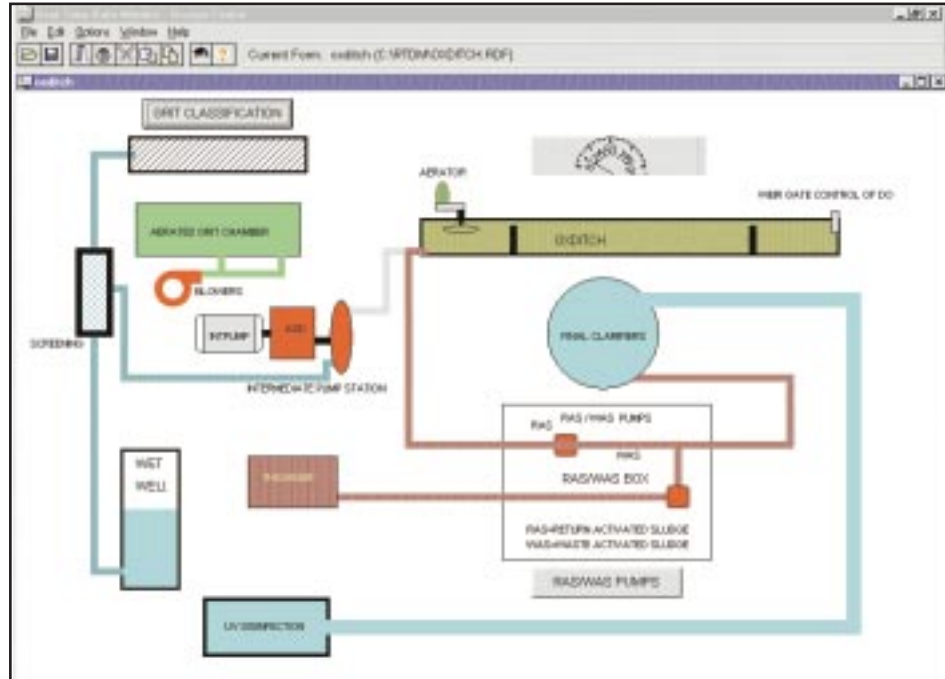
Campbell Scientific systems are seeing increased use in Supervisory Control and Data Acquisition (SCADA) applications. These systems typically consist of two components: a "Supervisory" component comprised of a central control computer and software, and a "Control And Data Acquisition" component made up of Remote Terminal Units (RTUs). The RTUs make measurements, report back to, then execute commands from, the Supervisory component.

SCADA systems are used in a number of industrial process and control applications. This article reflects our recent efforts toward water and wastewater treatment plants.

The Supervisory Component

In Campbell Scientific systems, the Supervisory component consists of a PC-compatible computer running CSI's Real-Time Data Monitoring (RTDM) and PC208W software. Alternatively, Wonderware, Intellution, or other software augmented by Modicon's Modbus software can be used. Our RTDM software runs on Windows 95, 98, NT and allows the operator in the treatment plant to monitor graphical screens with animated objects such as wet well levels, screens, grit chambers, centrifuges, chemical dosage rates, tank levels, pumps, clarifiers, digesters, filters, oxidation ditch weir levels, aerators, UV disinfectors, and chlorine and ozone injectors.

Operators watch the computer screen to view status and acknowledge alarms in



the plant and/or at remote sites. Remote lift stations, reservoirs, and pumping stations send data to RTDM via dial up leased phone lines, radio, or wide area network T1 links.

Control And Data Acquisition Component (the RTUs)

Our RTUs are the CR510, CR10X, or CR23X dataloggers, depending on the measurement and control capabilities needed at each locale.

Using Modbus with our SCADA Systems

Since its introduction by Modicon in 1979, Modbus has proven to be reliable, economical, and popular in worldwide SCADA networks. Modbus is a master/slave protocol that permits the Supervisory computer to communicate with the RTUs (slaves). This protocol is used by many manufacturers of PLCs (Programmable Logic Controllers) and RTUs. To operate in these systems Campbell Scientific RTUs must be equipped with a Modbus operating system (contact an applications engineer).

Before the release of RTDM, Campbell Scientific successfully installed CR10X RTUs in several customer SCADA sites, some of which use Wonderware's Intouch software as the Modbus master.

Modbus is RS-232, RS-485, and TCP/IP compatible over direct line, leased line, fiber optics, telephone, radio, microwave, satellite, Ethernet and internet connections.

Benefits of Campbell Scientific RTUs ...

- Store time-stamped data — up to 1 million data points
- No ladder logic
- On-board statistical and mathematical capability
- Calls out to voice modem or pager
- Peer-to-peer event and polled communication
- Provides extensive signal conditioning
- Interfaces with a wide variety of sensors
- Low power consumption
- Runs PIDs and controls without external support



The CR10X is one of three CSI dataloggers used as an RTU.

CS410 encoder tops list of new water resources sensors

CSI has recently released its own shaft encoder, the **CS410**. This encoder uses "silver-in-glass" technology to convert shaft rotation into two pulse strings that can be measured by a datalogger.

The float, float tape, counterweight, and pulley are sold separately. Other sensors added to our Water Resources Price List include:

CS420 Druck's submersible pressure transducer has a titanium body, a static accuracy of $\pm 0.1\%$ FS, is available in many psig ranges, and has vented polyurethane cable for barometric pressure compensation.

CS510 Oxyguard's dissolved oxygen probe is a self-polarizing galvanic probe

that provides automatic temperature compensation.

CSIM11 Innovative Sensors' pH probe has a pre-amplified signal, does not require an interface, and operates over the full pH range. An ORP version is also available. For details, call an applications engineer at 435-750-9693. ☑

Soil water content measurements

Considering variability and uncertainty

By Jim Bilskie, Ph.D.
Campbell Scientific

A common issue among workers measuring soil water content is how many measurements are required for a good estimate of water content in a managed unit. A unit can be a small test plot, an irrigated field, or a waste storage site. Multiple measurements taken within a meter of each other often show a surprising amount of variability. The uncertainty introduced by the spatial variability can render a water content estimate useless.

Uncertainty from water content variability adds to other uncertainties inherently present in each measurement. Most significant is uncertainty from instrument error, which is any distortion of the actual value introduced by the sensor, including calibration error. While the uncertainty from instrument error is beyond control of the user, careful sampling and prudent interpretation of measured values will improve the water content estimate when spatial variability is present. This article presents a simple approach for improving water content estimation under spatially variable conditions.

Spatial Variability

A measurement at a single location is seldom representative of water content in the entire unit. Variability of soil water content can result from spatial differences in soil parent material, plant transpiration, erosion, compaction and other processes that affect soil structure.

Fundamentally, the scale of an individual measurement must be considered relative to the scale of the spatial variability. Variability can be present on scales of centimeters to kilometers. If an instrument has a sensitive volume large enough to sample an entire unit with a single measurement, spatial variability does not affect the estimate. But the sensitive volume of available water content measurement methods is small enough that spatial variability must be considered when choosing a measurement scheme. Given this difference in scale, measurements at multiple locations are required when estimating water content in a unit.

Relating Spatial Variability and Uncertainty

One way to express the results of multiple water content measurements is to combine the mean with the uncertainty of

the mean. An example data set is used to demonstrate this method. Ten water content measurements were collected with a HydroSense™ (see article on adjacent page) at different locations in a cropped field.

Units: $m^3 m^{-3}$				
0.18	0.18	0.24	0.17	0.17
0.22	0.18	0.22	0.22	0.22
mean = 0.20				
standard deviation = 0.025				
range = 0.07				

The seven percent difference between the high and low readings is evidence of spatial variability and illustrates that a single measurement is inadequate. The mean value is accepted as the best estimate. The uncertainty of the mean volumetric water content ($\delta\theta_v$) is calculated by dividing the standard deviation (s) by the square root of the number of measurements (n). The water content estimate with uncertainty (θ_v^*) for this data set is

$$\theta_v^* = \bar{\theta}_v \pm \delta\theta_v = \bar{\theta}_v \pm \frac{s}{\sqrt{n}} = 0.20 \pm 0.008 m^3 m^{-3}$$

with $\bar{\theta}_v$ the mean of individual measurements. Assuming normal distribution of the data, this result states that the mean of the ten measured values is within ± 0.008 of the actual water content value with a confidence level of 68 percent. The confidence level increases to 95 percent if the uncertainty is doubled;

$\theta_v^* = 0.20 \pm 0.016 m^3 m^{-3}$. To add perspective to this, let the unit be the size of a football field with a soil profile depth of 20 cm. The uncertainty of $0.008 m^3 m^{-3}$ or 0.8 percent volumetric water content translates into nearly 2000 gallons of water. Compare this with the uncertainty of nearly 6000 gallons for a single measurement.

Combining Measurements

There are instances when two measurements must be added or multiplied to calculate an estimate. In general, if two quantities are added to calculate an estimate, the uncertainties of the individual

quantities are added to get the total uncertainty. When the quantity is a product or quotient, relative uncertainties are added. The relative uncertainty is simply the uncertainty divided by the mean.

Relative uncertainty is applied to a sample data set collected to estimate volumetric water content using oven drying and known sample volume.

	Gravimetric water content ($kg kg^{-1}$)	bulk density ($kg m^{-3}$)
mean (\bar{x})	0.199	1233
standard deviation (s)	0.006	74.0
uncertainty (δx)	0.002	23.4
relative uncertainty ($\frac{\delta x}{\bar{x}}$)	0.009	0.019

Assuming the density of water is $1000 kg m^{-3}$, the mean volumetric water content is the product of the mean gravimetric water content ($\bar{\theta}_g$) and the mean bulk density ($\bar{\rho}_b$) and is $0.24 m^3 m^{-3}$ for these data. The uncertainty is expressed with the mean in the estimate as

$$\theta_v^* = \bar{\theta}_v \pm \left[\frac{\delta\theta_g}{\bar{\theta}_g} + \frac{\delta\rho_b}{\bar{\rho}_b} \right] * \bar{\theta}_v = 0.24 \pm 0.007 m^3 m^{-3}$$

This result states that the actual volumetric water content lies between 0.233 and 0.247 at a 68 percent confidence level or between 0.226 and 0.254 at a 95 percent confidence level. The uncertainty for bulk density is generally higher because of errors from core sampling.

Summary

Spatial variability of soil water content must be considered when measurements are collected to estimate the water content of a managed unit. The uncertainty of the estimate can be calculated using simple statistical methods. The calculation of uncertainty can then provide guidance on the number of measurements required to obtain the desired level of confidence in the estimate. Experience in monitoring water content and careful evaluation of measurements will lead to an optimum sampling scheme and efficient use of water.

HydroSense™ now available

Collaborative effort creates soil water instrumentation

Campbell Scientific is adding a new product to its line of soil water measurement instrumentation. The HydroSense™ is the result of a collaborative effort between CSI and Campbell Scientific Australia (CSA; Townsville, QLD).

The CD620 handheld display, manufactured by CSA, is built around a PIC microcontroller. The display unit connects to the CS620 sensor, developed by CSI, via a two-meter coiled cable. The probe consists of an electronic circuit encapsulated in epoxy. Replaceable rods are 5 mm in diameter and are available in 12- and 20-cm lengths. A measurement is made by fully inserting the rods into the soil and pressing the READ button. The measurement result is provided on a two-line alphanumeric display.

The HydroSense's two operating modes provide flexibility in a variety of applications. The water content measurement mode applies factory calibrations to the probe output and displays volumetric water content in percent. Also displayed in this mode are the period of the probe output signal and the length of rods being used.

The water deficit mode allows the user to set lower and upper water content references by taking measurements under those conditions and storing the values in memory. Up to five sets of reference values can be stored allowing specific monitoring under different crop and soil combinations. Once ref-



The HydroSense makes soil water monitoring quick and easy.

erence values are stored, subsequent measurements provide a display of the relative water content and the water deficit. Relative water content ranges from 0 to 100 percent and corresponds to the lower and upper reference values, respectively. The deficit value indicates the amount of water which must be added to bring the water content to the upper reference value.

Operating modes are easily switched by holding one front panel button down while the other is pressed. Pressing either button wakes the HydroSense from sleep mode, which occurs automatically after about two minutes of measurement inactivity. Two AA batteries provide enough power for thousands of instantaneous, high precision measurements.

The SC100: Our one-channel serial data interface

The SC100 filters and buffers data between a serial sensor and a CR10(X) or 21X datalogger. It is used in applications where the sensor transmits serial ASCII data asynchronously (i.e., a 4800 bps Global Positioning System receiver).

The datalogger uses Program Instruction 15¹ and control ports to read data sent from the SC100. P15 reads data stream transmissions at 300 and 1200 bps only. The SC100 buffers up to 90 bytes of serial data received at 1200, 2400, 4800, 9600, 19200 and 38400 bps then transmits the buffered data to the datalogger at 1200 bps. The data (or commands) can also be transmitted from the datalogger to the sensor when required.

In the received data, the SC100 searches for a six-character, user-specified ASCII string (e.g., \$GPGGA). It then buffers all data following the string until it encounters a termination character (e.g., carriage return). The SC100 and datalogger use control ports to coordinate data transfer; incoming data is placed in datalogger input locations to allow further processing or transfer to final storage.

A minimum of five sequential control ports are required to receive serial data. A seven-conductor cable is required to connect the datalogger to the SC100 (the other two conductors are used for power and ground). The SC100 is powered by the datalogger's 5 or 12 VDC supplies; power consumption is 55 mA active, 50 µA quiescent.

1. Program Instruction 15 is supported as a standard instruction in the CR10X and CR23X dataloggers. The CR10 and 21X require a \$300 library special EPROM. The CR500, CR510, CR7 and CR9000 dataloggers do not support instruction 15 and cannot use the SC100 interface. The CR23X can buffer data through its control ports and serial port; therefore the SC100 is not required.

Training courses offered

CSI conducts three-day training courses on our dataloggers and PC software. Classes are held monthly for the CR10X and PC208W, and quarterly for the CR9000 and PC9000.

Download a course itinerary, registration form, scheduling and local travel information from our Web site, or call 435-753-2342.

DCP: Where dataloggers meet satellites

The DCP100 combines the measurement and control capabilities of our dataloggers with the broad geographic coverage afforded by GOES (Geostationary Operational Environmental Satellite) telemetry. With an operating temperature range of -40° to +60°C, the DCP100 is a rugged, reliable system even in extreme, remote environments.

U.S. Federal, State, or local government agencies or users sponsored by one of those agencies may use the GOES system. Potential GOES users must receive formal permission from NESDIS.

Campbell Scientific systems have been configurable as Data Collection Platforms (DCP) for many years. But now the

DCP100 combines the necessary components into a single compact package to make configuring your DCP system as easy as 1-2-3.

- 1) Specify a CSI DCP100;
- 2) Choose a datalogger option; and
- 3) Choose a power supply option.

A transmitter, antenna, enclosure, and battery charger are all included in the DCP100 package.

If you already have a Campbell datalogger, no problem. We can build a GOES platform around your CR500, CR510, CR10(X), 21X, or CR23X. For more information contact one of our applications engineers.

Argos satellite telemetry now standard for data retrieval

Campbell Scientific now offers Argos satellite telemetry as a standard method of data retrieval. Argos telemetry features one-way data transmission from remote sites to ground stations via Argos Polar Orbiting Environmental Satellites. The system is administered in the U.S. by Service Argos and is dedicated to monitoring and protecting the environment. CSI applications include meteorology (automated weather stations in Antarctica), oceanography (ocean buoys in the Atlantic Ocean), and water resources management (Amazon River Basins).

Because the satellites are polar orbiting, the number of passes over a given geographic location is a function of the site's latitude. In general, there are about 28 passes per day over the North and South Poles and about eight passes per day at a given location along the equator. The satellite is overhead for about 10 minutes per pass. Most users are allowed to transmit a one-second duration data stream every 90 or 200 seconds. The data stream equates to 16 CSI low-resolution data points. Because the transmitter does not "know" when the satellite is overhead, a data stream must be re-transmitted during a number of intervals to ensure reception. In general, the higher the site's latitude and the less redundancy required to ensure all data is captured, the more data can be transmitted.

Data Delivery

The satellites receive data messages from users' transmitters and store them on tape. When the satellites pass over one of the Argos ground stations they read out ("dump") the data. From there data is electronically forwarded to processing centers where the raw data is extracted from the satellite data sets. From that point, accessing the data is easy. The user can retrieve results from anywhere in the world by public data networks, often within 20 minutes of transmission. Service Argos currently offers data delivery via Internet e-mail, Internet Telnet session, and dial-in modem. Other delivery services include diskette, tape, and hard copy. It is important to note when the data is collected, the user is required to convert the raw binary data back into a decimal format. The Argos satellite instruction manual (supplied with each system) provides details on accomplishing this conversion.

Satellite Hardware and Datalogger Firmware

Campbell Scientific offers the Argos-Certified ST-13 Transmitter (from Telonics, the same manufacturer as our GOES-Certified TGT1 Transmitter), a synchronous interface and cable, a test receiver, and an optional marine half-wave antenna with mounts.

Instruction 121, standard in CR500, CR510, CR10X, and CR23X operating systems, is required for Argos telemetry. Instruction 121 is available for the CR10 as a Library Special EPROM. The transmitter is interfaced to the datalogger's nine-pin CS I/O port.

The ST-13 requires 7-14 VDC. Current consumption is 525 mA at 14 VDC during the one-second transmissions. Quiescent current is less than 100 μ A. System power budgets are less than 0.2 Ahrs per day for the ST-13 transmitter and interface.

Using the ARGOS System

A formal application process is required to send data via Argos. There is also a monthly charge to use the system. Because a radio signal is sent to the satellite, users must contact their national telecommunications authority for authorization to use the Argos Uplink frequency (401.650 MHz). Users in the United States must apply for a Federal Communications Commission (FCC) License. FCC forms 552 and 159/159C are required.

For further information on Argos and the FCC visit the following Web sites:

<http://www.argosinc.com>

<http://www.fcc.gov>

RF300-series synthesized radios are now shipping

The RF300 series, CSI's new line of UHF- and VHF-synthesized data transceivers from Johnson Data Telemetry Corporation are now shipping. CSI will program these radios with the customer's FCC-assigned frequency. The new radios use our RF95A modem which supports channel selection and power saving modes.

Fire weather stations offered

CSI offers specialized weather stations for monitoring conditions indicative of fire danger. These stations are compatible with Remsoft's WeatherPro software, which provides WIMS access and NFDRS computations.

CSI gear braves Hurricane Georges

In September 1998, Hurricane Georges battered Puerto Rico. For a first-hand account and a look at the data gathered by Dr. Karim Altaii using Campbell Scientific weather stations, see www.campbellsci.com/georges.html

Meet Campbell Scientific at:

Date	Exhibit	Location
March		
1-4	Society of Automotive Engineers International Expo	Detroit, MI
4-6	California Aquaculture Association Conference and Exhibit	Monterey, CA
April		
20-21	Western Snow Conference	South Tahoe, CA
May		
4-6	Sensors Expo	Baltimore, MD
June		
20-24	Air and Waste Management Association Annual Meeting and Exhibit	St. Louis, MO
20-24	American Water Works Association Annual Conference and Exposition	Chicago, IL



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